

JULY 2019



**WIM #48
CSAH 5,
MP 15.05
STORDEN, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

System Operation

WIM #48 was operational for the entire month of July 2019. Volume was computed using all monthly data.

System Calibration

WIM #48 was most recently calibrated on 2018-06-12. Table 1 summarizes the front axle weights of class 9s by lane ¹. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation ². Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 13187 | Passenger Vehicles: 10276 | Heavy Commercial Vehicles: 2911

Monthly Average Daily Traffic (MADT): 390 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 94

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Tuesdays, with lowest volumes reported on Wednesdays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Fridays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 01 PM and 05 PM. Similarly, SB PVs peaked in volume between 10 AM and 01 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 01 PM and 05 PM, while volume going SB peaked between 10 AM and 01 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 10's.

Overweight HCVs

Volume trends. Of a total of 2911 HCVs, 783 of them were overweight ³. These overweight HCVs contributed to 6.8% of total monthly volume, and 30.8% of total monthly HCV

volume. NB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Wednesdays, with lowest volumes reported on NAs. See Figure 3 .

The top two overweight violators by class were the class 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 71.9% of all overweight vehicles traveling SB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in September.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report ⁴.

Using normal load limits ,31 NB vehicles exceeded 88,000 pounds (15 vehicles were Class 13's; 14 vehicles were Class 10's). Of vehicles traveling SB,

230 NB vehicles exceeded 88,000 pounds (94 vehicles were Class 9's; 68 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in July 2019. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling NB, while there were more fully_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 29939 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (63.8%) than NB (36.2%). See Table 4 and Figure 11 for more freight information.

####Infrastructure Considerations Bridge. Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 13187 vehicles with a combined GVW of 183635 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 2762 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 68.6% of all ESALs were recorded SB while 31.4% was observed NB. In particular, 53% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 34% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:

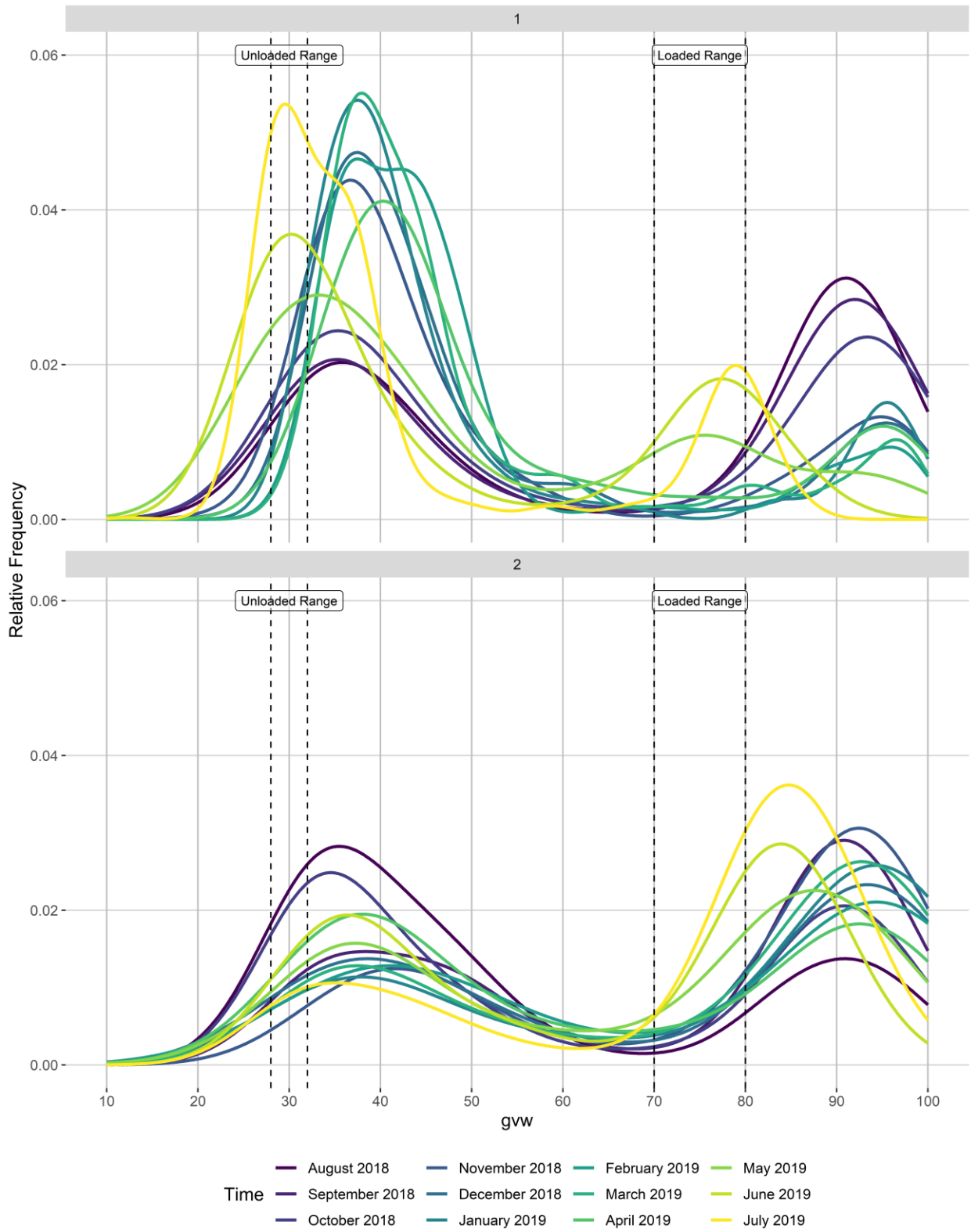
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at:
<http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- ² Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- ³ An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes:
http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp
- ⁴ For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

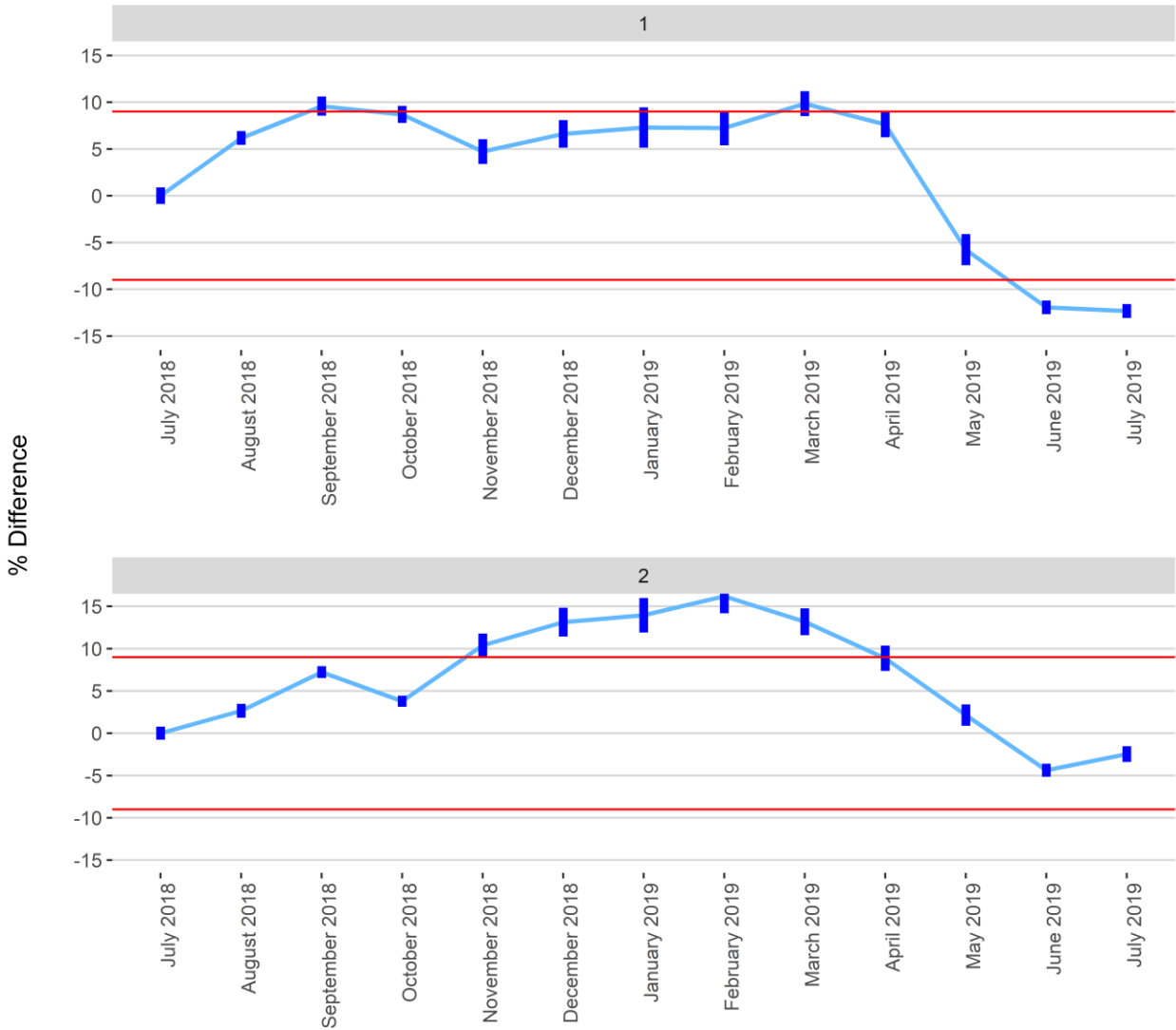
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from
Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume
vs. Day of the Week

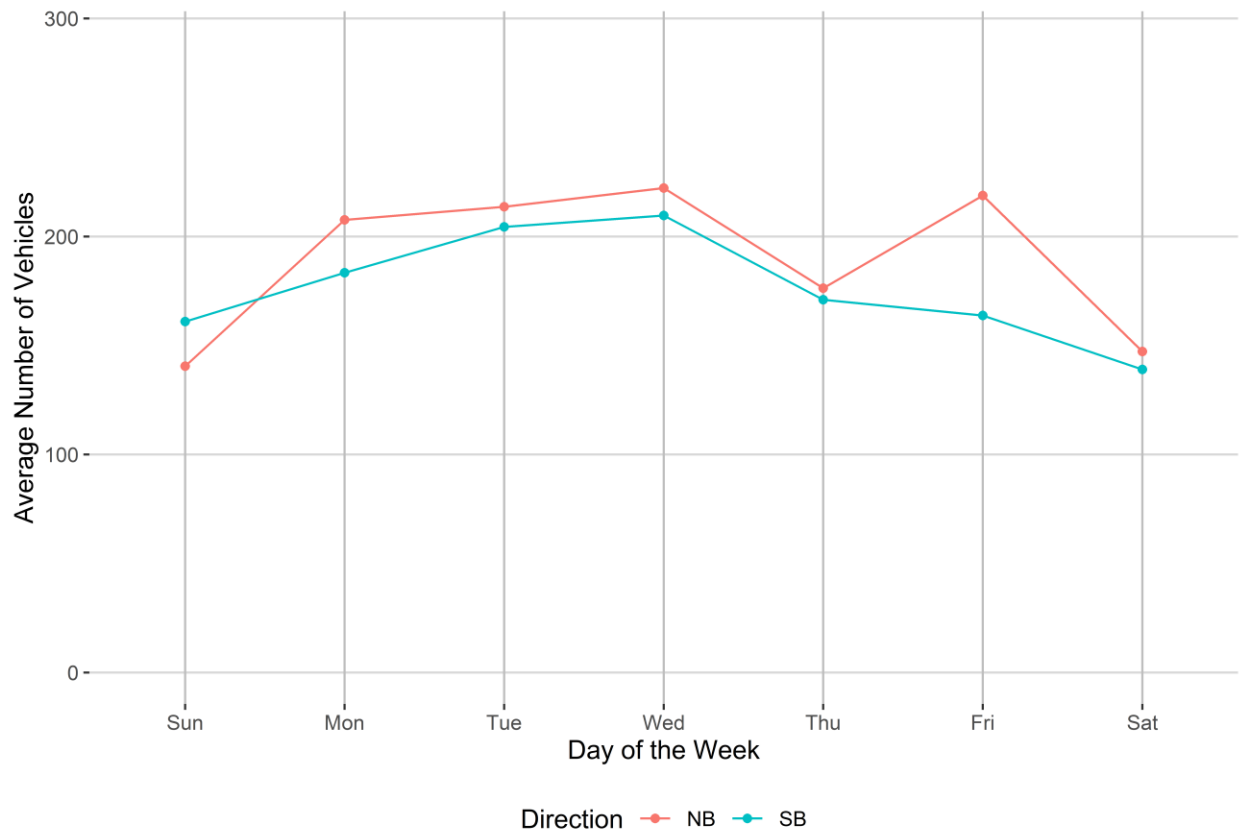


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

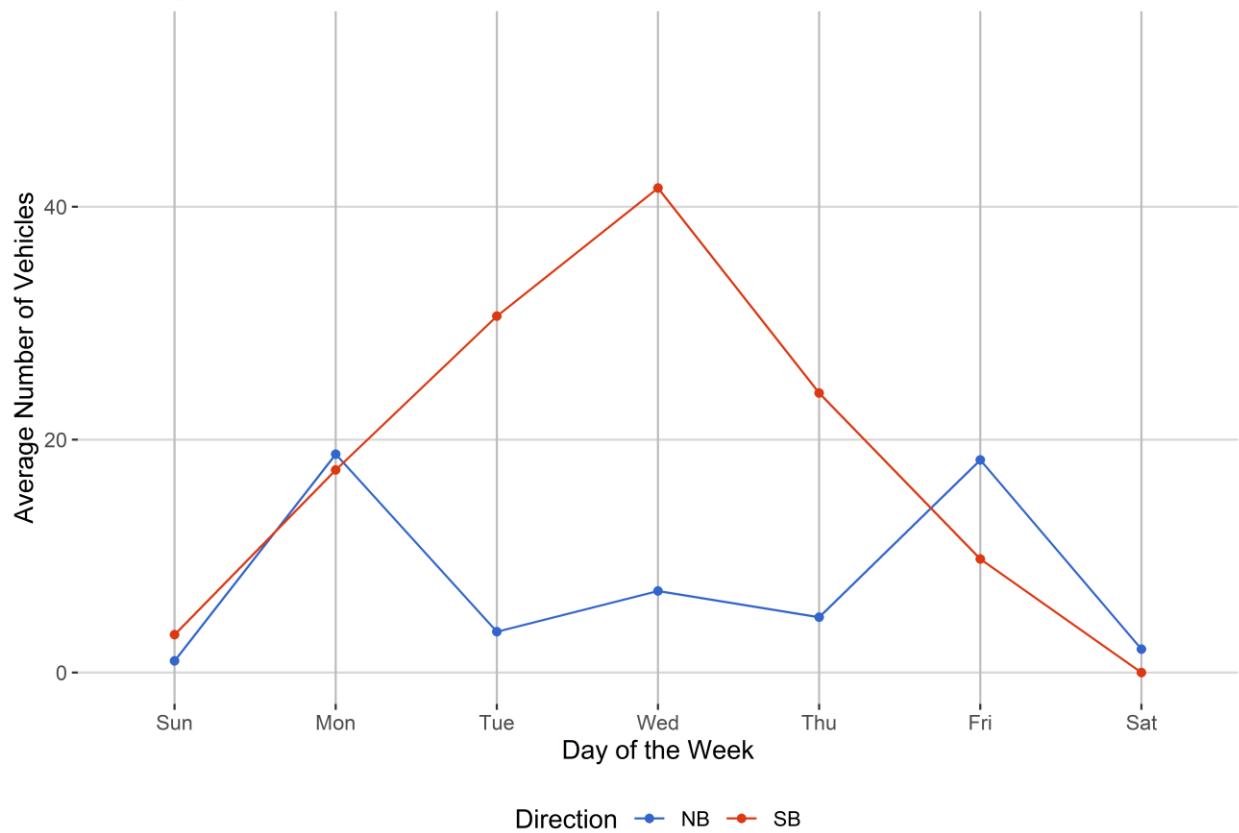


Figure 4 - Passenger Vehicles
vs. Hour of the Day

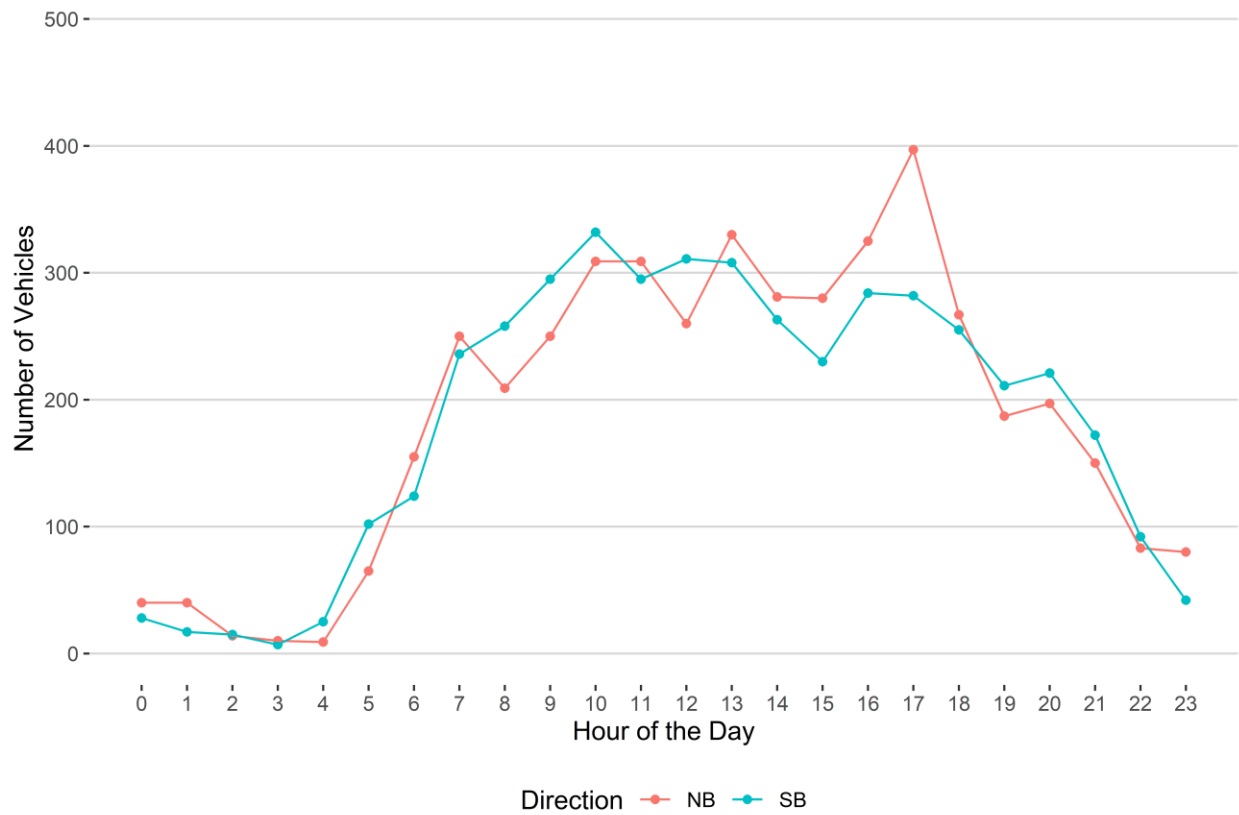


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

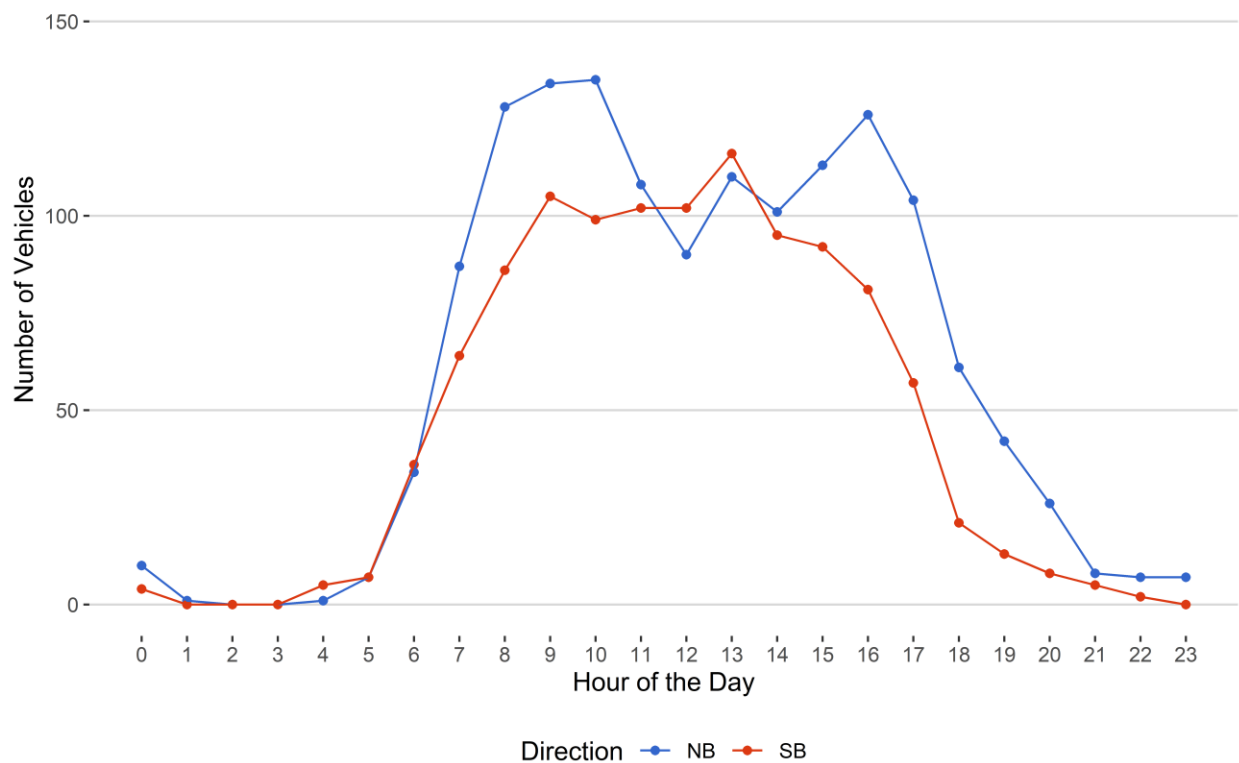


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

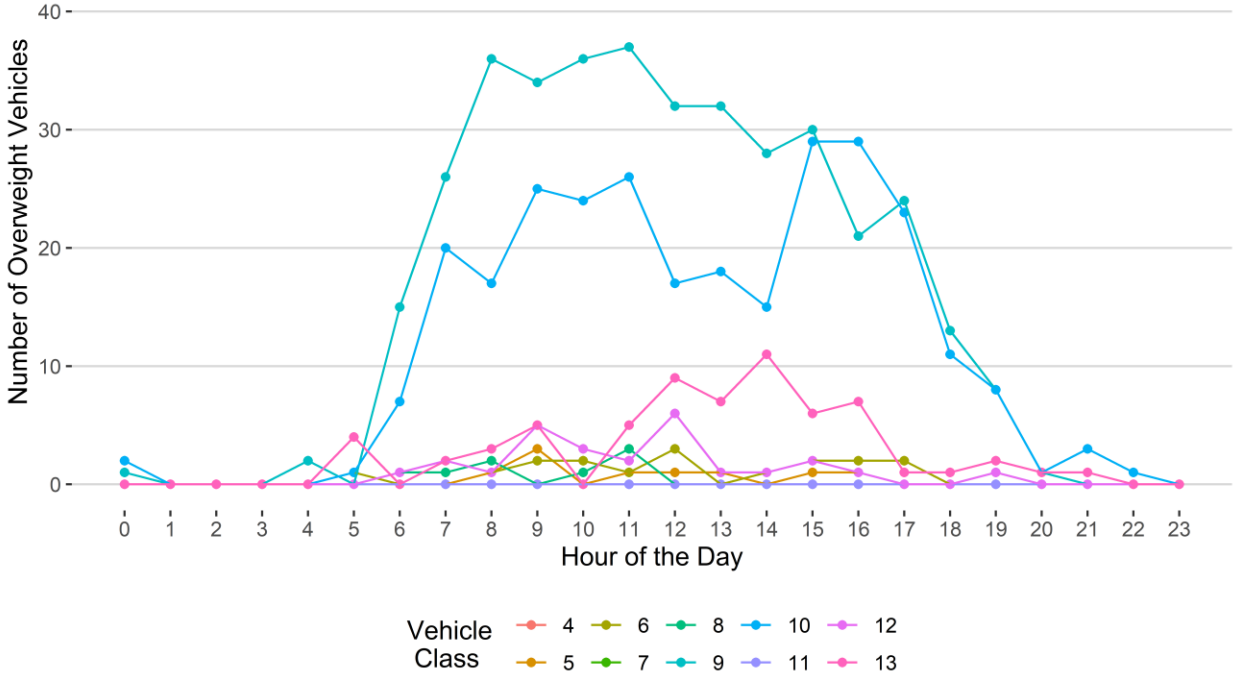


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

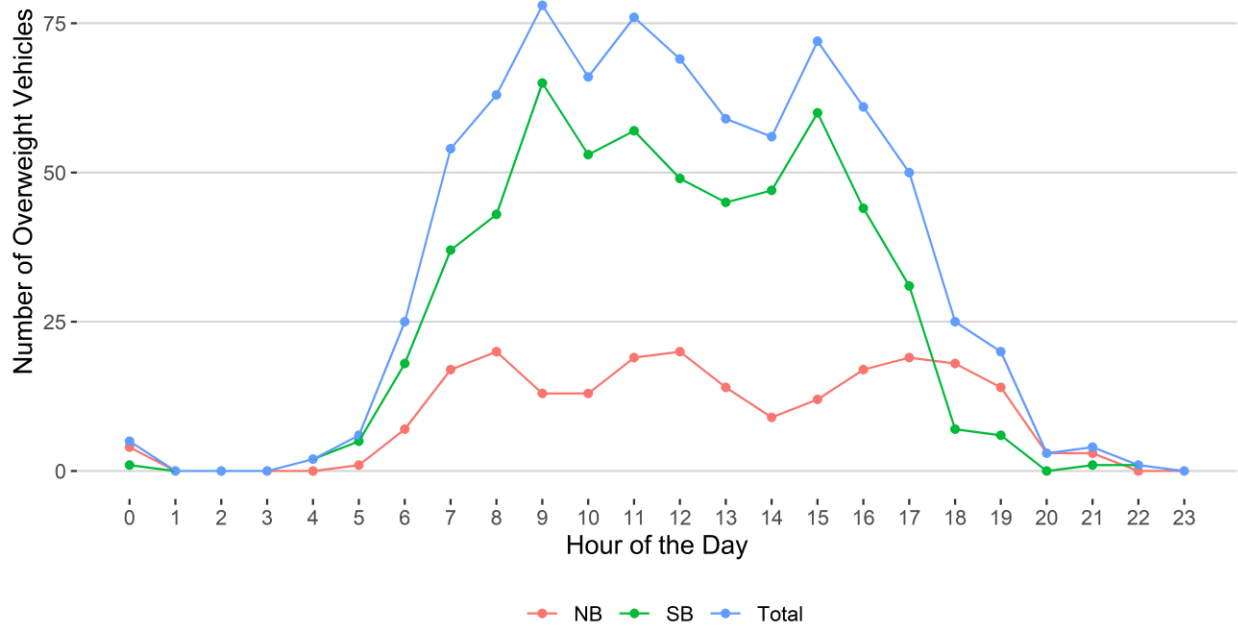
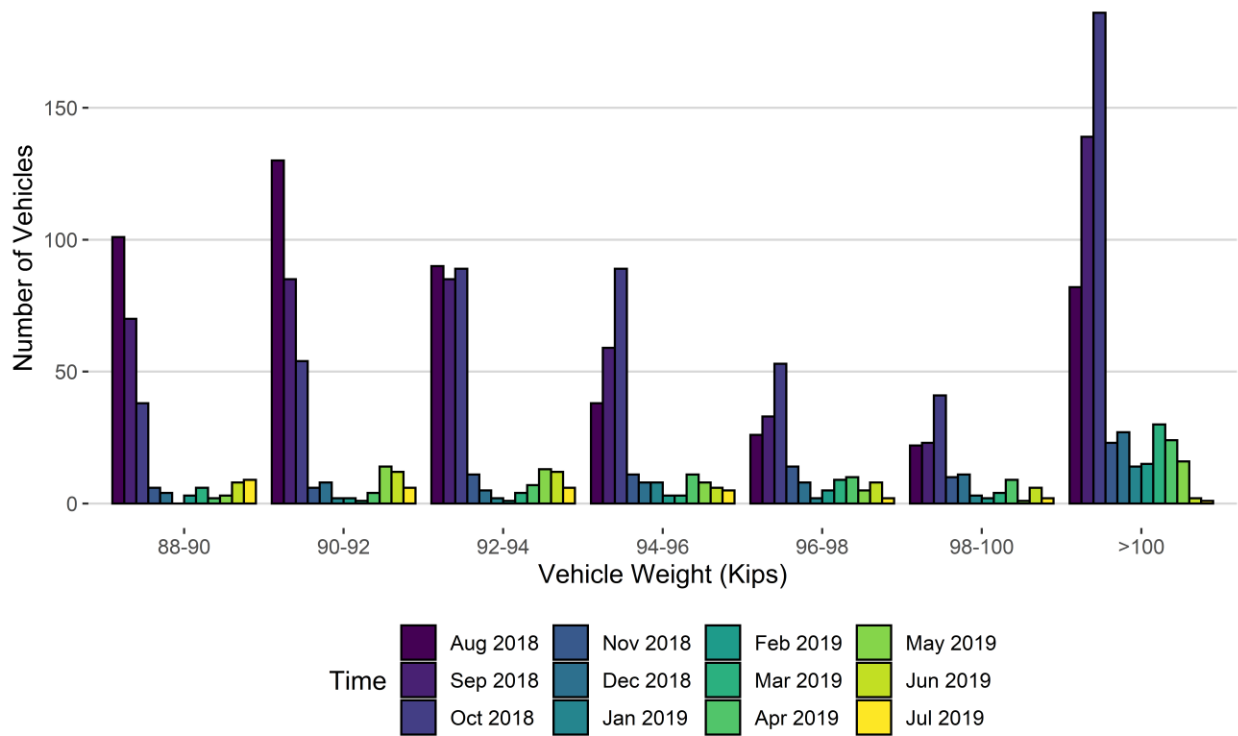
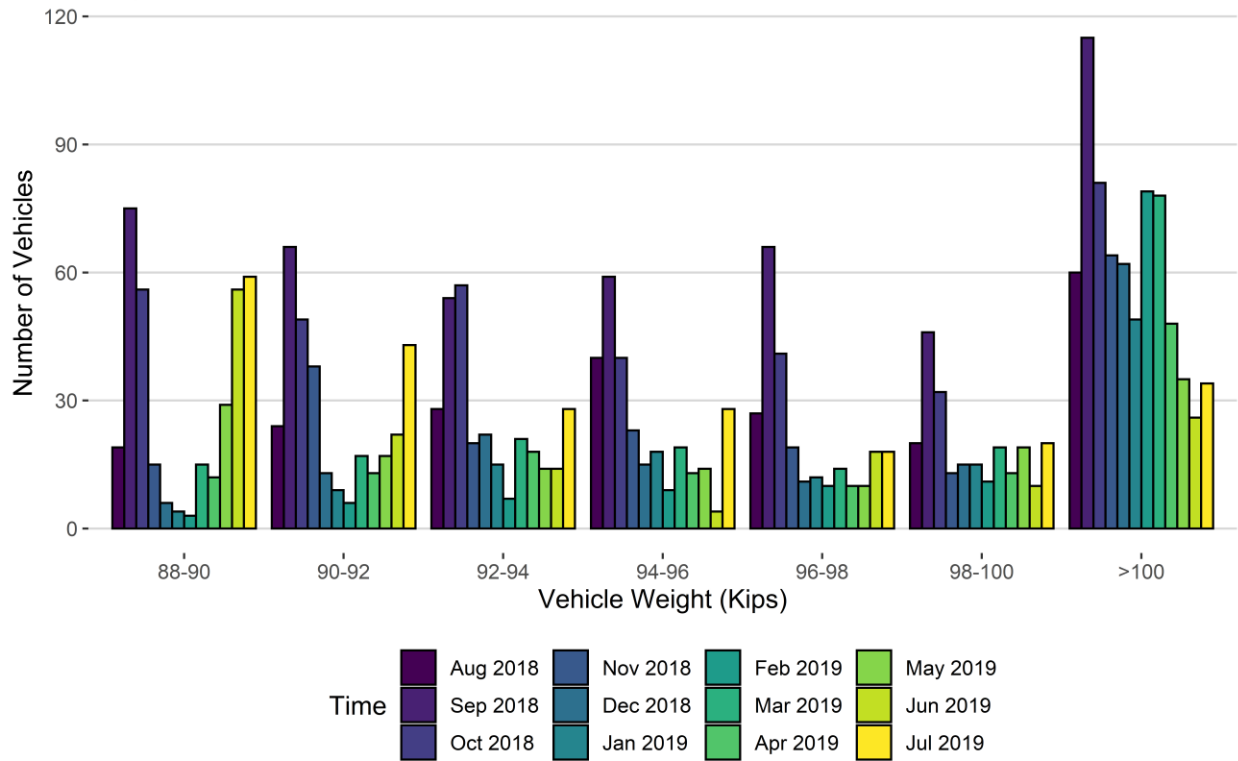


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019
88-90	101	70	38	6	4	0	3	6	2	3	8	9
90-92	130	85	54	6	8	2	2	1	4	14	12	6
92-94	90	85	89	11	5	2	1	4	7	13	12	6
94-96	38	59	89	11	8	8	3	3	11	8	6	5
96-98	26	33	53	14	8	2	5	9	10	5	8	2
98-100	22	23	41	10	11	3	2	4	9	1	6	2
>100	82	139	186	23	27	14	15	30	24	16	2	1
Total	489	494	550	81	71	31	31	57	67	60	54	31

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019
88-90	19	75	56	15	6	4	3	15	12	29	56	59
90-92	24	66	49	38	13	9	6	17	13	17	22	43
92-94	28	54	57	20	22	15	7	21	18	14	14	28
94-96	40	59	40	23	15	18	9	19	13	14	4	28
96-98	27	66	41	19	11	12	10	14	10	10	18	18
98-100	20	46	32	13	15	15	11	19	13	19	10	20
>100	60	115	81	64	62	49	79	78	48	35	26	34
Total	218	481	356	192	144	122	125	183	127	138	150	230

Figure 8 - Class 9's and 10's by Direction
vs Gross Vehicle Weight

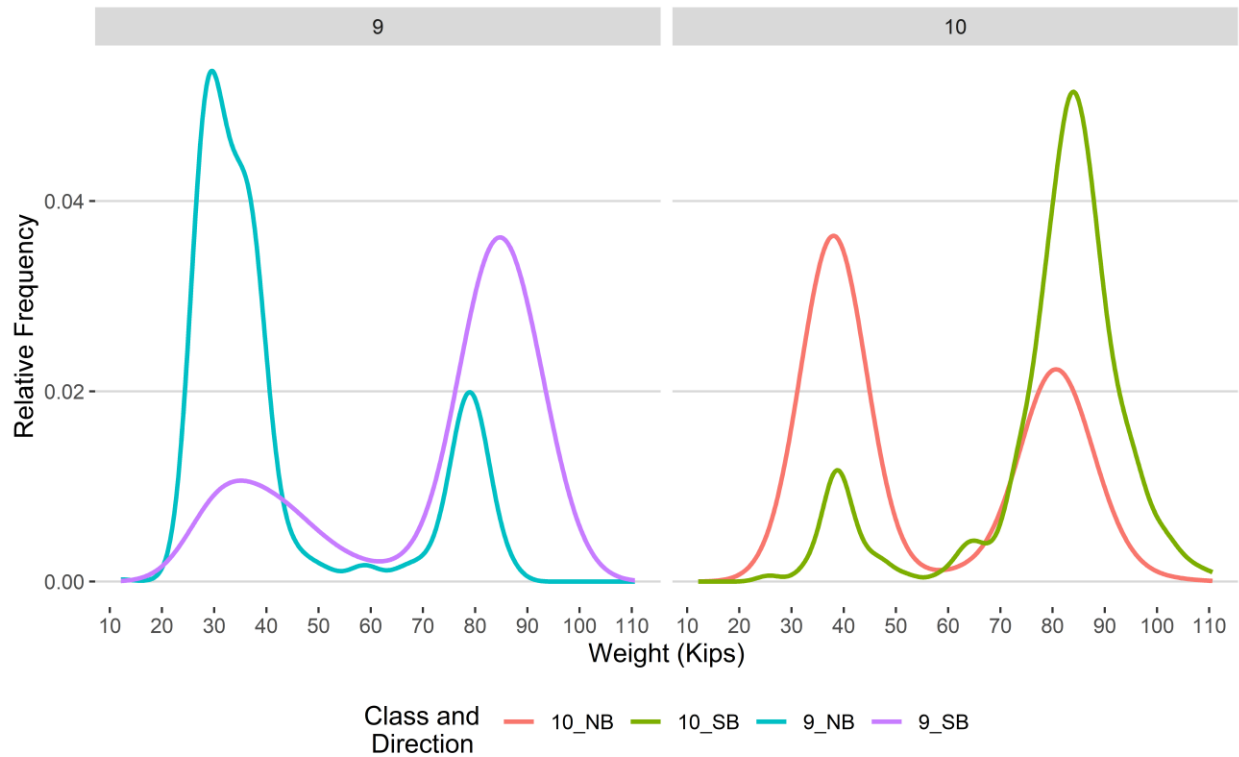


Figure 9 - Freight Percentage
by Direction and Class

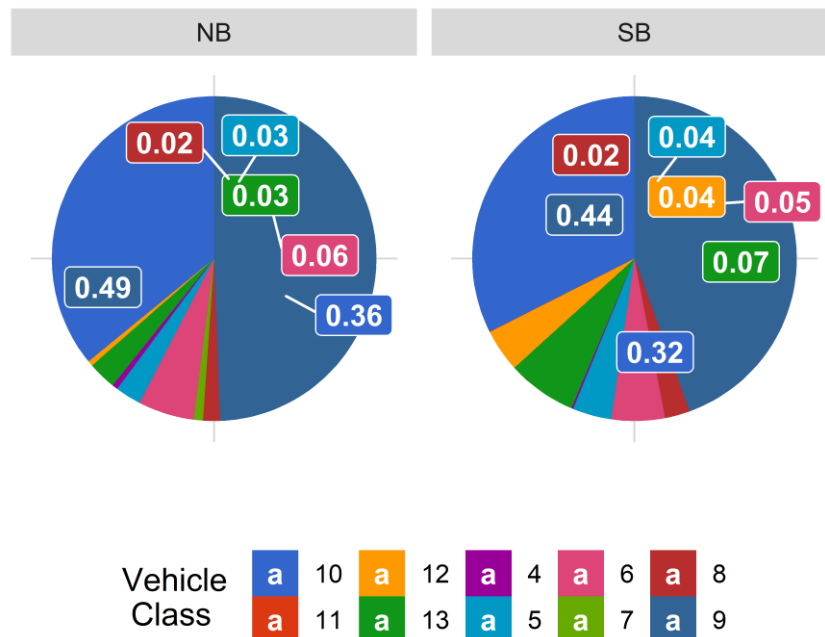


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

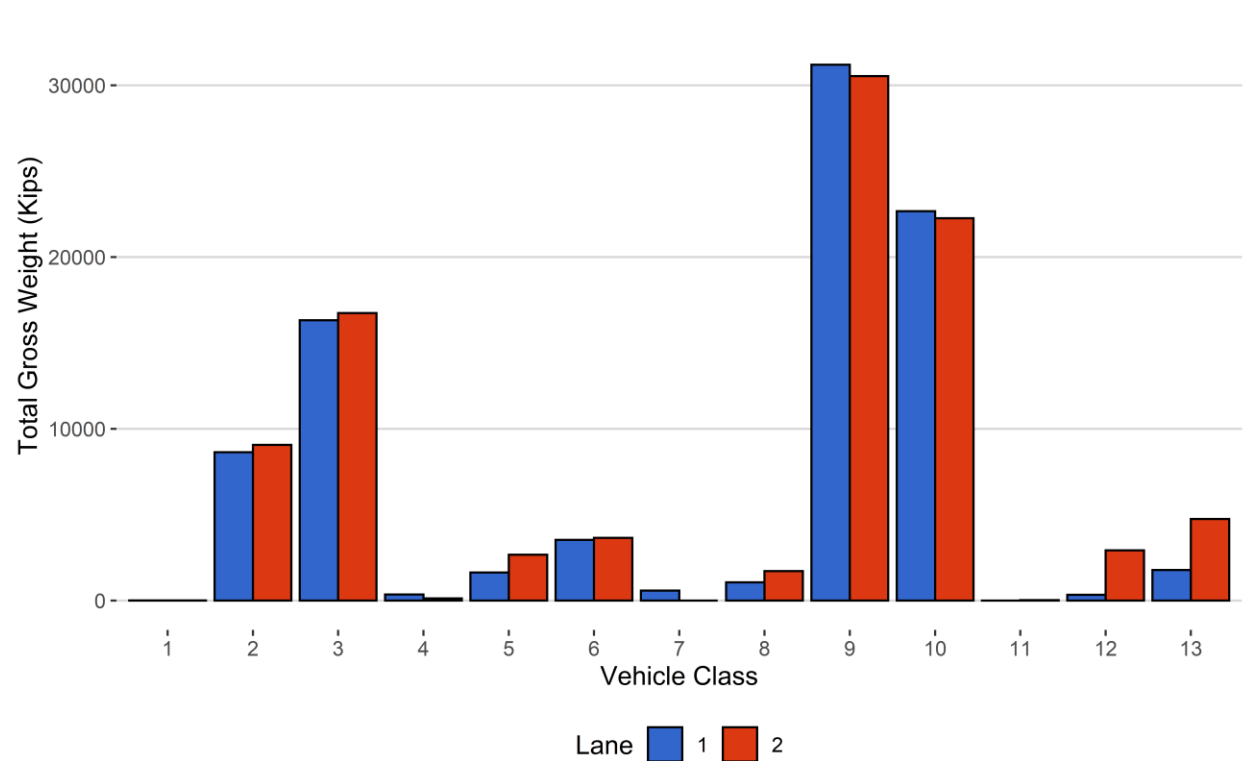


Figure 11 - Total Gross Vehicle Weight t

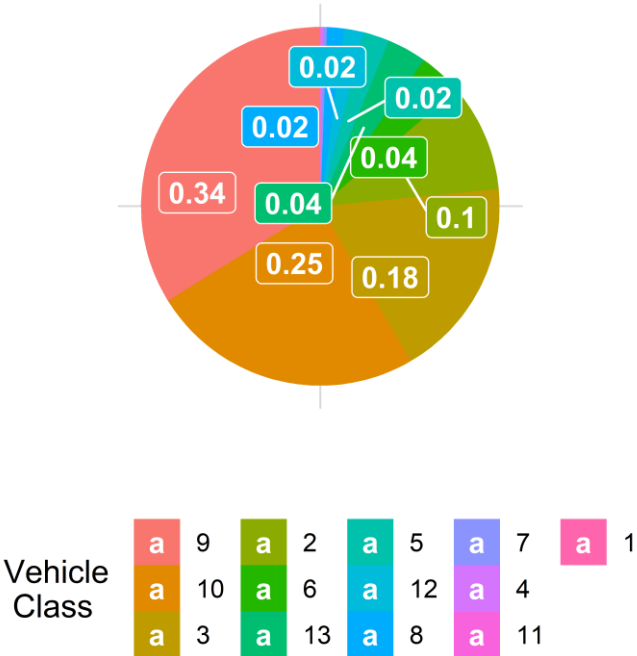


Figure 12 - Total ESALs by Class and Lane

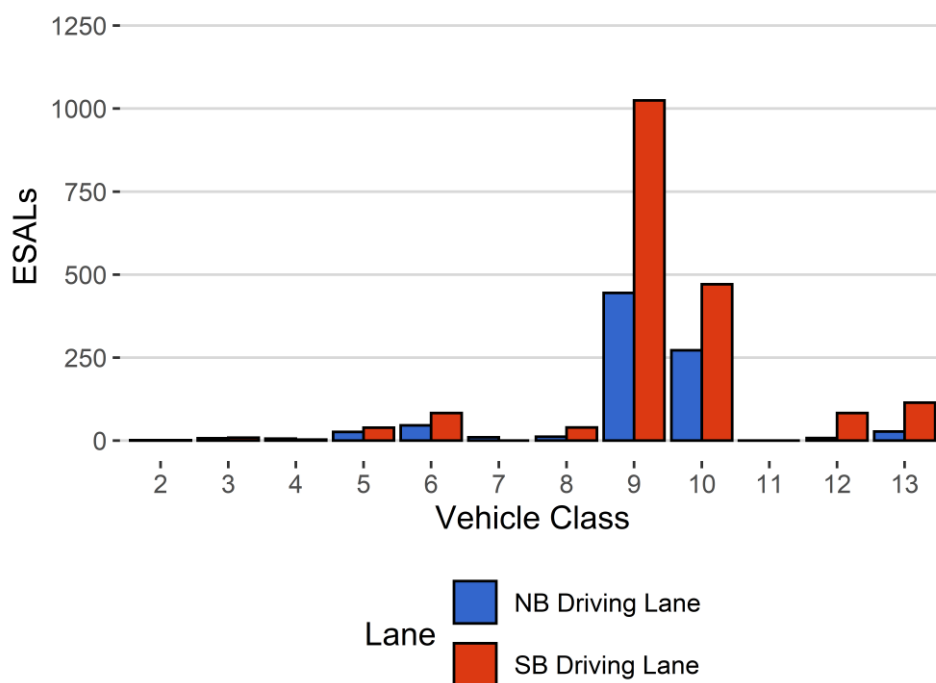


Figure 13 - ESALs by Class

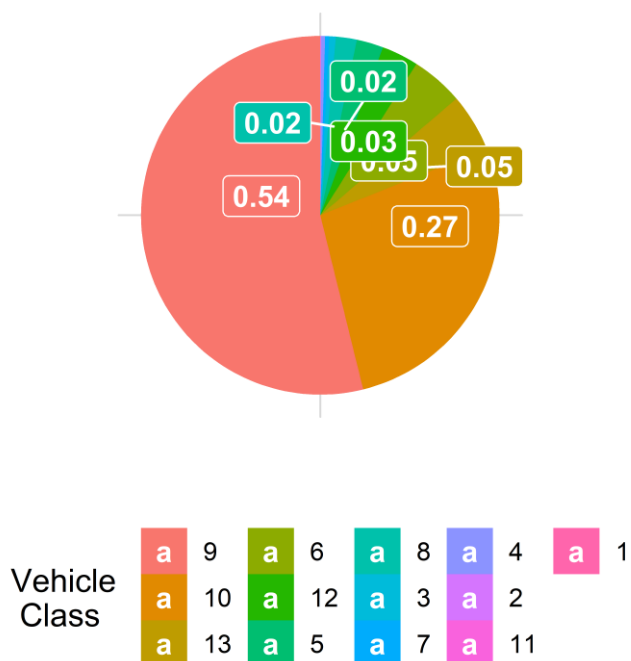


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
July 2018	11.77	0.00	11.70	0.00
August 2018	12.50	6.18	12.01	2.65
September 2018	12.90	9.58	12.54	7.23
October 2018	12.80	8.70	12.14	3.78
November 2018	12.33	4.72	12.91	10.39
December 2018	12.55	6.61	13.23	13.13
January 2019	12.63	7.29	13.33	13.95
February 2019	12.62	7.24	13.59	16.20
March 2019	12.93	9.85	13.24	13.18
April 2019	12.67	7.62	12.73	8.86
May 2019	11.09	-5.77	11.95	2.15
June 2019	10.37	-11.93	11.18	-4.38
July 2019	10.32	-12.33	11.41	-2.46

Table 2 Vehicle Classification Data

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	0	10	0.1	0	0
2	155	4803	36.4	0	0
3	176	5462	41.4	0	0
4	1	19	0.1	2	0.3
5	11	327	2.5	10	1.3
6	8	240	1.8	19	2.4
7	0	10	0.1	0	0
8	3	83	0.6	8	1
9	43	1325	10	376	48
10	25	787	6	277	35.4
11	0	1	0	0	0
12	1	42	0.3	26	3.3
13	2	77	0.6	65	8.3
TOTAL	425	13187	100	783	100

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2019-07-17	Wednesday	08:50:05	10	SB	2	111.72
2019-07-31	Wednesday	12:20:44	10	SB	2	110.61
2019-07-29	Monday	10:37:01	10	SB	2	107.65
2019-07-25	Thursday	13:35:45	10	SB	2	106.02
2019-07-30	Tuesday	17:08:34	10	SB	2	103.9
2019-07-30	Tuesday	11:18:50	10	SB	2	103.86
2019-07-29	Monday	16:56:10	10	SB	2	102.07
2019-07-18	Thursday	10:45:45	10	SB	2	101.48
2019-07-11	Thursday	15:09:43	10	NB	1	101.4
2019-07-25	Thursday	10:23:33	10	SB	2	101.37

Table 4 Freight Summary

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	NB	15	13	0	0	354	0	80
5	NB	8	110	19	17.3	1496	139	384
6	NB	19	115	5	4.3	3438	89	674
7	NB	11.5	9	0	0	578	0	237
8	NB	31	31	13	41.9	736	324	89
9	NB	33	732	312	42.6	22197	9000	4168
10	NB	33.5	406	11	2.7	22321	347	4544
12	NB	36.5	4	0	0	334	0	94
13	NB	31.5	20	0	0	1773	0	572
TOTAL	****	****	1440	360	****	53226	****	10842
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	SB	15	4	0	0	121	0	31
5	SB	8	175	10	5.7	2599	70	640
6	SB	19	94	4	4.3	3578	73	934
8	SB	31	41	5	12.2	1609	105	246
9	SB	33	424	38	9	29391	1139	8326
10	SB	33.5	281	2	0.7	22203	58	6428
11	SB	36.5	1	1	100	0	22	0
12	SB	36.5	33	0	0	2925	0	860
13	SB	31.5	47	0	0	4744	0	1632
TOTAL	****	****	1100	60	****	67169	****	19097
GRAND TOTAL	****	****	2540	420	241	120396	11365	29939

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	7	4	11	0
2	8631	9062	17694	9.7
3	16319	16737	33056	18.1
4	354	121	476	0.3
5	1635	2669	4304	2.4
6	3526	3651	7177	3.9
7	578	0	578	0.3
8	1060	1713	2773	1.5
9	31197	30530	61727	33.8
10	22668	22261	44928	24.6
11	0	22	22	0
12	334	2925	3259	1.8
13	1773	4744	6517	3.6
TOTAL	88082	94440	182522	100
GVW/LANE	48.26	51.74	100	0.05

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.1
2	1	1	2	0.1	0.0017
3	7	9	16	0.6	0.0076
4	6	3	9	0.3	1.07
5	26	39	66	2.4	0.48
6	46	83	129	4.7	1.25
7	10	0	10	0.4	1.71
8	12	40	52	1.9	1.41
9	445	1024	1470	53.9	2.58
10	272	471	743	27.2	2.19
11	0	0	0	0	0.92
12	8	83	91	3.3	4.01
13	27	114	142	5.2	3.77
TOTAL	861	1869	2729	100	19
ESALS/LANE	31.6	68.5	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCADT</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>
Aug 2018	13562	438	85	10928	80.6	2634	19.4
Sep 2018	14017	467	98	11073	79	2944.3	21
Oct 2018	14892	480	112	11407	76.6	3485.3	23.4
Nov 2018	11107	370	47	9686	87.2	1421.5	12.8
Dec 2018	9594	310	39	8393	87.5	1201.4	12.5
Jan 2019	7052	282	28	6187	87.7	864.7	12.3
Feb 2019	7600	271	38	6535	86	1065.2	14
Mar 2019	9909	320	46	8474	85.5	1435.2	14.5
Apr 2019	10547	352	44	9227	87.5	1320.3	12.5
May 2019	12728	404	53	11098	87.2	1629.9	12.8
Jun 2019	12277	409	53	10701	87.2	1576.4	12.8
Jul 2019	13187	390	94	10276	77.9	2911.1	22.1
TOTAL	136472	-	-	113985	-	22489	-
AVERAGE	11373	374	61	9499	84	1874	16

###ESALs

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Aug 2018	2494	1632	4127	86.4
Sep 2018	2756	3014	5769	85
Oct 2018	3327	2736	6063	97
Nov 2018	707	1320	2027	88.4
Dec 2018	581	1022	1603	97.2
Jan 2019	315	859	1173	100.9
Feb 2019	426	1097	1523	116.2
Mar 2019	617	1276	1894	103.2
Apr 2019	589	898	1486	78.3
May 2019	606	1263	1869	61.4
Jun 2019	955	2099	3054	30.8
Jul 2019	868	1894	2762	37.4
TOTAL	14240	-	-	-
AVERAGE	1187	1592	2779	82

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Aug 18	104470	87394	191864
Sep 18	101402	112503	213905

Oct 18	120755	111263	232018
Nov 18	53687	60504	114190
Dec 18	46511	49899	96410
Jan 19	27108	36968	64076
Feb 19	32684	39784	72467
Mar 19	47910	55089	102999
Apr 19	51115	53745	104860
May 19	60319	69785	130104
Jun 19	107647	132267	239913
Jul 19	88299	95336	183635
TOTAL	841904	904537	1746441
AVERAGE	70159	75378	145537

Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Aug 2018	907	7.4	37.3	708	185
Sep 2018	1229	10.1	47.7	976	324
Oct 2018	1250	9.4	39.9	907	341
Nov 2018	401	3.9	30.1	274	110
Dec 2018	286	3.2	25.2	216	116
Jan 2019	216	3.6	29.4	154	82
Feb 2019	237	3.8	26.4	156	107
Mar 2019	339	3.9	26.3	240	131
Apr 2019	261	2.7	21.2	194	94
May 2019	389	3.3	25.3	200	71
Jun 2019	716	3.2	24.7	204	44
Jul 2019	795	6.9	30.9	261	57
TOTAL	7026	-	-	4490	1662
AVERAGE	585.5	5.1	30.4	374.2	138.5

Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Aug 2018	19506	13260	32765	59.5	40.5
Sep 2018	19864	22935	42800	46.4	53.6
Oct 2018	23691	19714	43405	54.6	45.4
Nov 2018	5662	9780	15442	36.7	63.3
Dec 2018	4620	7430	12050	38.3	61.7
Jan 2019	2455	5954	8409	29.2	70.8
Feb 2019	3307	6523	9830	33.6	66.4

Mar 2019	4989	9102	14091	35.4	64.6
Apr 2019	5153	7228	12381	41.6	58.4
May 2019	6527	9850	16377	39.9	60.1
Jun 2019	10389	17912	28301	36.7	63.3
Jul 2019	10842	19097	29939	36.2	63.8
TOTAL	117005	148784	265788	-	-
AVERAGE	9750.4	12398.6	22149	40.7	59.3